Project Work Statement

Task Descriptions

The project consists of three distinct tasks: background research, interface standards development, and interface review, testing, and acceptance. Each task will produce a written report and serve as the basis for the following tasks, though at times more than one task will be in progress.

Task 1: Background Research

While the ultimate goal of the project is to design a new standard interface for power management, we will first review the state of existing controls. We will learn what has and hasn't worked from the experience of typical users and interface designers, what the art and science of interface design suggest about an ideal interface, and what institutions should be involved in defining a standard.

1.a. Inventory and assessment of devices and interfaces

In this task we will survey the current implementation of power management interfaces. Office equipment that currently has power management capability includes computers (PCs and others), monitors, fax machines, printers, copiers, scanners, and multi-function devices. Devices that turn themselves on at specified time (such as a VCR or microwave oven—even coffee machines) are also effectively power managing and so may benefit from standard interface elements. We will identify the types of office (and ultimately home) devices that currently have power management capability, as well as those which do not today but will likely have it in the future. For each device type we will indicate the broad category of interface characteristics that the device does or could have, such as delay timers, day/time controls, responses to external inputs (such as occupancy or computer network activity), and whether a device controls itself or is controlled by another device. Our primary focus is office equipment, but we will also address other kinds of electronic equipment, though at a reduced level of detail.

Within each device type we will survey a wide variety of brands and models and evaluate their power management controls and indicators. This would include the specific features present in the interface, the terms and symbols used, implied behavior[8], helpful information provided in the interface (e.g. the relative amount of energy saving from different options), and underlying metaphors used to communicate the idea of (and rationale for) power management. We will also record the "indicators" of power management occurring, such as power lights changing color or blinking, displays dimming or turning off, textual or symbolic indicators on a display, changes in noise, vibration, or heat emissions, or summaries of power status over time. Finally, few devices have a mechanism for "checking" power management configuration separate from the ability to change it. However, experience in measuring and trying to maximize the savings from power management points up the need for mechanisms to check power management configuration, even in cases in which much of the device (including potentially sensitive controls) is password-protected or otherwise hidden. Some power management controls can only be set or checked by service personnel. Some interfaces are dependent on the particular software installed on the device, and in other cases, an add-on device or add-on software defines the interface. We will note the degree of agreement between terms and symbols on screens and those used next to power switches on the same device.

With the data gathered, we will categorize and group control elements and strategies to see what patterns appear in their distribution across device types, vintage, etc. We will use general information about equipment stocks to get an indication of which control strategies are most prevalent. We will inventory how such controls are described or represented in places apart from the

[8] An example of this is the presence of two or more timers that control when multiple lower power states are entered. It is often not clear if they operate in series or in parallel, so that it isn't clear what are appropriate values to set the timers to.

controls themselves, such as in documentation (on-line, on paper, or otherwise), and marketing materials.

We will also address where the controls are found, in hardware and software terms. On PCs for example, they may be available only on system reboot, only through a control panel, or both. Controls may be "hidden" under a certain type of menu; may be available only to the "key operator" of a device (sometimes with password protection); or set by a hardware switch inside the machine. Even the physical locations of the power and 'sleep' switches are important.

The type of hardware interface that a device has also affects its power management controls. These include a high-resolution screen, as on a PC; a touch screen, as on some copiers; a small LCD or LED character display, as on some printers and copiers; or an interface accessed from a second device via network connections[9]. Some devices have more than one hardware interface. There may be a high degree of correlation between the physical interface and the power management control strategy used.

1.b. Literature Survey

We will review the literature on user interfaces for electronic devices generally, and to a lesser extent that for other kinds of devices. We expect to find little on power management controls specifically, but do expect the literature to provide guidance on choosing terms, symbols, metaphors, and control and indication mechanisms. As we expect these controls to be adopted globally (at least in part), attention should be taken to any cultural pitfalls that should be avoided in choices of symbols and words. Controls that have redundant symbology are more resistant to misinterpretation than single-mechanism ones. One example is using a term and symbol together; another is pedestrian 'walk/don't-walk' signs that have both color and a symbol or text. We may conclude that we should establish standard colors for power states. We will summarize approaches or factors that seem particularly relevant to power management controls.

This is by no means the first attempt at standardizing a user interface for convenience, safety, or other goals. We will review the development of other relatively standard user interfaces that may indicate pitfalls or opportunities for standardization of power management interfaces. Examples may include automobiles, plumbing, or audio/video equipment. Examples of failed or poorly executed standard interfaces will also be assessed, for the lessons they hold.

1.c. Field Research

The energy efficiency field is replete with concepts that work one way in the laboratory but differently in the field. To gain more insight into the human dimensions of the controls, we will interview a variety of typical office workers, MIS managers, and energy managers. Our questions will address their reaction to power management controls and indications, their assumptions about it (particularly if it differs from reality), how they see that it could be improved, and what works particularly well. We will conduct testing of a variety of interface designs and elements on people to assess the degree to which they are understood, misinterpreted, or seen as confusing. This activity will to gather the range of opinions and ideas and a general sense of their prevalence, not come to statistically rigorous conclusions.

We will also interview those responsible for designing power management interfaces and those who market the devices and must explain them to customers. Through this process we expect to find out why the particular implementations were chosen, what alternatives were discarded and why, and what (with the benefit of hindsight) is seen as a better or optimal user interface.

It would be desirable to have statistically valid quantitative data on how often power management is enabled with different kinds of controls, to empirically assess their performance. However, it is unlikely that such data currently exist, gathering it would be a large task, and confounding factors such as differences in equipment performance make drawing strong conclusions difficult. Thus we will not include that in our field research.

[9] Printers are increasingly being managed this way, as are some network infrastructure devices.

1.d. Institutional Review

Standards are rarely successful when merely asserted or implemented by one party. Rather, a variety of institutions exist to discuss, establish, and revise standards, to give them the credibility for others to use and rely on. We will review the various organizations that have existing or potential interest in office equipment power management control standardization. They have a variety of interests and goals, including safety, interoperability, and international coordination.

Organizations we expect to assess include: the International Electrotechnical Commission (IEC), the International Standards Organization (ISO), the National Institute of Standards and Technology (NIST), the American National Standards Institute (ANSI), the American Society for Testing and Materials (ASTM), and the Information Technology Institute (ITI, formerly the Computer and Business Equipment Manufacturers Association). In addition, standards in the computer industry are sometimes coordinated by trade associations, such as the Video Electronics Standards Association, and other times by more informal standards processes, some of which are conducted entirely through electronic communication. Power management is not directly a safety issue, but power indications, switches, and symbols are a concern of those who are, so guidelines and principles from safety will be reviewed to see if standards should be changed based on this.

1.e. Summary and Analysis

We will prepare reports outlining the results of the tasks above, both detailed reviews of what was found, and more brief summaries of the main points and conclusions. We will solicit critical reviews, particularly from those in industry who design user interfaces, so that the final documents reflect the range of opinion and thought on the topic. In particular, in particular, we will seek comments from people in other countries, to confirm that power management approaches are similar in other languages, or if not, how they differ.

Task Schedule: Begin the first month of the project, and end June 30, 2000.

Deliverables: Quarterly updates on each subtask, with a final report June 30, 2000.

Task 2. Interface standards development

The goal of Task 2 is to build an improved standard interface on the foundation laid by the background work of Task 1. For the standards to succeed, they will have to be broadly acceptable to a wide variety of constituencies. For the review and revision process to be seen as credible, it will need to be clear and open, and without bias towards any particular company or technology. However, if elements of an existing implementation already have wide recognition and understanding, that cannot be ignored.

During the course of Task 2, we will work with key industry representatives to have access to the best ideas and knowledge that could be applied to the development of the interface.

2.a. Interface Structure

Based on the results of Task 1, we will identify the types of elements that the standard should include, and their relation to each other. There may be logical groupings of devices or interface types that suggest specifications tailored to that group, based on both capability and need. Other elements of the structure will also be identified. These are expected to include concepts for which standard terms and symbols are needed, as well as overall principles that the standards should be derived from or be consistent with.

It may be important to define the intended limits of the standard, to be able to judge its ease of implementation, and where other approaches might be better suited. Some devices may be too small to warrant attention, or not be suited to control or indication separate from a larger device. Others may be sufficiently complicated, or largely used by dedicated operators, so that the standard interface is less appropriate (energy-intensive devices such as commercial refrigeration or building heating and cooling systems are likely examples).

It is likely that this standard could be readily adapted to many other devices, such as home electronics, but *doing* that adaptation, including the requisite testing and acceptance, is beyond the scope of this project. We will note ways that related standard controls such as imaging could be structured, but do not expect to actively pursue that within this project.

We will identify one or more promising approaches for a standard power management user interface, and discuss how these would be implemented in the range of power manageable devices. An important part of this task will be to write up the *rationale* for the choices made so that reviewers and those who will consider adopting the standard will best understand them. We will solicit comments from interface designers on the approaches, and identify any emerging consensus. It may be that the range of power manageable devices is so broad that more than one set of approaches or variations is required. In that case, we will seek to minimize their number and any conflicts among them.

2.b. Interface Details

This task will fill out the structure created in Task 2.a with specifics such as standard terms and symbols, indicators, and "operational defaults"[10]. As with Task 2.a, we will prepare a discussion of the reasons for the choices made. We will also create mockups of the controls, both entirely new ones, and adaptations of existing controls to make them conform to the standard. The mockups would be presented as static, graphic images, and to the extent possible, implemented on the world wide web to be available interactively.

Tasks 2.a and 2.b will necessarily occur in parallel. We see value in separating the structure from the details as we expect this will better allow the standard to evolve as new capabilities and needs arise. It should also facilitate international variations, as different languages may use the same structure but with different terms (though ideally the symbols will be consistent).

Task Schedule: Begin October 1, 1999, and end September 30, 2000.

Deliverables: Quarterly updates on each subtask, with a final report September 30, 2000.

Task 3. Interface review, testing, and acceptance

This task will both refine the standard and work for its acceptance both directly in the market (equipment manufacturers) and with established standards organizations.

3.a. Review

In the background research (Task 1), we will have identified many individuals and organizations that have interests in the project. We will solicit comments on the proposed standard to identify any potential problems with it, or additional features it should have. We plan to have just one main review cycle, though may conduct smaller consultations before or after the main cycle.

3.b. Testing

As the reaction of ordinary users to the new power management controls is the ultimate indicator of project success, we will conduct limited testing of it on "average" users to see how well they understand it and how easily they are able to modify it to their needs. We will seek to partner with others who conduct such testing on an ongoing basis (e.g. manufacturers and university-based researchers) to have the interface subjected to their standard tests. We are not in a position to organize any international testing, but will encourage others to do so independently. If substantial deficiencies or potential improvements are identified in the testing, the standard will be revised and

[10] An 'operational default' is an aspect of the operation of a power management system that can be assumed if not explicitly stated. One example is whether timers for multiple low-power modes operate in serial or parallel. Another is whether a usage-based or timer-based control takes precedence.

retested. The ultimate results of the testing should be confirmation that the interface is easy to understand, and evidence for manufacturers and standards organizations that it will be well received.

3.c. Acceptance

The final stage of the project is to ensure its use in future office (and other) equipment so that the anticipated savings are obtained. The two principle methods will be to work with manufacturers and with standards organizations, as identified in Task 1.d, the Institutional Survey.

From Task 1.d we will know which organizations should be targeted for this task, what existing standards might be affected, if a new standard is needed (or just a modification of existing ones), and which technical committees need to be approached. The International Electrotechnical Commission has a number of technical committees which appear to be relevant. Even with advance notice, some standards organizations move very slowly, particularly international organizations that must respond to concerns from many countries. Thus, some of the standards adoption process may not be complete when the project ends. However, we hope that these will be far enough along to carry forward on their own inertia, and with the efforts of others interested in the success of improved power management.

Task 1.d will also identify the manufacturers most critical to the success of the interface. We will work with these leading equipment manufacturers—particularly those in California—to attain the greatest incorporation of the standards possible. As companies in the information and electronics business tend to move quickly, actual incorporation of the new user interface technology might occur in advance of official adoption by standards organizations. Some implementations may be distributable with ordinary software updates without waiting for entire new hardware purchases. However, we see both activities as complementing the other, providing mutual confidence that the standard is acceptable and can succeed.

Finally, we will be working closely with the EPA ENERGY STAR program to assure that the standard does not interfere with the program, and enhances it as much as possible. EPA can use its relationship with the manufacturers to encourage cooperation with the project, and ultimately, consider adoption of the standard (or parts of it) into the program requirements.

Task Schedule: Begin January 1, 2000 and end March 31, 2001.

Deliverables: Quarterly updates on each subtask, with a final report March 31, 2001.